MICRONAIRE TESTING OF COTTON SAMPLES IN PREVAILING ATMOSPHERIC CONDITIONS

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Cotton Division

AGRICULTURE-WASHINGTON

WASHINGTON, D. C. 1954

SUMMARY

The testing of cotton samples by use of the Micronaire air-flow instrument has been adopted by large segments of the cotton industry. The expansion of its use, however, has been limited because controlled atmospheric conditions are necessary to obtain reliable results.

Previous studies indicate that, in tests using the Micronaire, differences in results caused by atmospheric conditions are affected most by the amount of fiber included in a standard weight specimen. The procedure used in this study was devised to adjust the weights of the specimens in order to compensate for moisture content in different atmospheric conditions, and thus provide reliable Micronaire results when controlled atmospheric conditions are not available.

The objective of the study was to ascertain, by empirical tests, the accuracy of the reproducibility of the Micronaire results when this procedure is employed in a wide range of prevailing atmospheric conditions.

The procedure employed consists of the standard Micronaire test, except for the method of weighing the specimen. Instead of using a standard 50-grain specimen, a calibration cotton, which had been weighed previously in the standard atmosphere of 65 percent relative humidity and 70 degrees F., was used as the weight on the back pan of the scales. The weight of this calibration cotton changed as the relative humidity changed, and the weights of the specimens were adjusted to balance the calibration cotton. This method was employed in testing each of 5 selected cottons in the prevailing atmosphere at the cotton laboratory at College Station, Texas, both in the morning and in the afternoon, 5 days a week for 4 weeks.

An average trend line, calculated from the results of this study, indicates that the average Micronaire value for the 5 cottons range from 4.4 micrograms per inch, when tested in atmosphere of 87 percent relative humidity, to 4.6 micrograms per inch, when tested in atmosphere of 37 percent relative humidity. These humidities of 87 and 37 percent, respectively, were the extreme conditions encountered during the study. There is an indication that relative humidity affects the level of the Micronaire results for the coarse-fibered cottons more than it does for the fine-fibered cottons, but this is probably the result of the curvilinear nature of the Micronaire scale which has smaller graduations for the higher values.

Ranges of the results for each of the 5 cottons tested indicate that the accuracy of the reproducibility of the Micronaire values, when the tests are performed in the prevailing atmosphere by using this method, is within a standard error of plus or minus 0.09 micrograms per inch. A comparable average standard error of 0.05 micrograms per inch was obtained in a previous study in which the tests were performed under standard atmospheric conditions. Although this comparison shows that the results are more reliable when performed in controlled atmosphere, the Micronaire values obtained in the prevailing atmosphere are sufficiently reliable for the practical application of this method when controlled atmosphere is not available. Such values would be expected to be statistically within a range of plus or minus 0.2 micrograms per inch of the true value when tested in atmosphere ranging from 37 to 87 percent relative humidity.

MICRONAIRE TESTING OF COTTON SAMPLES IN PREVAILING ATMOSPHERIC CONDITIONS 1/

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INTRODUCTION

The Micronaire air-flow instrument provides a rapid method for determining the relative fiber fineness of cotton samples. The operation of this instrument is simple, and its use has been adopted by large segments of the cotton industry. The expanded use of this instrument in cotton classing offices, however, has been limited because atmospheric conditions affect the results and most of these offices do not have controlled atmospheric conditions.

Published reports 2/ indicate that relative humidity has a significant effect on the Micronaire results and that temperature has an insignificant effect. They also indicate that the effect of relative humidity on the test results of the Micronaire is composed of two separate factors that operate in opposite directions.

Cotton samples in atmosphere of high relative humidity contain a higher percentage of moisture than they do in atmosphere of low relative humidity. A standard weight specimen, therefore, contains less fiber and more moisture when the relative humidity is high. The smaller amount of fiber under these conditions offers less resistance to air-flow and results in a higher micronaire reading.

On the other hand, the larger amount of moisture swells the fibers, causing them to offer additional resistance to air-flow, thus lowering the Micronaire reading slightly. The effect of the decreased amount of fiber, however, is much greater than the effect of the swelling of the fibers. Consequently, the resultant Micronaire values are higher when the tests are performed in atmosphere of high relative humidity than they are when tested in atmosphere of low relative humidity.

1/ The study reported in this publication was planned and conducted under the administrative direction of John W. Wright, Chief, Standards and Testing Branch, Cotton Division of the Agricultural Marketing Service. Acknowledgement is made to Samuel T. Burley, Jr., Head of the Testing Section, for technical supervision, and to the cotton laboratory at College Station, Texas, for conducting the tests essential to this study.

2/ Burley, Samuel T., Jr., and Rouse, Joseph T. Effect of Atmospheric Conditions on Testing of Certain Cotton Fiber Properties. Research and Testing Division, Cotton Branch, USDA. October 1953.

Gates, Florence R., and Jennings, Edwin J. The Effect of Relative Humidity on Micronaire Readings. Textile Res. Jour. 23(12). December 1953.

From these findings, it was logical to assume that a procedure in which the weight of the specimen is adjusted for differences in moisture content would provide Micronaire results which are, for practical purposes, comparable when tested in a wide range of uncontrolled or prevailing atmospheric conditions. Such a procedure was devised, and the empirical study on which this report is based was conducted at the Cotton Laboratory of the Cotton Division, Agricultural Marketing Service, at College Station, Texas. The study was designed to ascertain the accuracy of the reproducibility of the Micronaire results when this procedure is used under prevailing atmospheric conditions.

PROCEDURE

The following procedure was used in performing the tests:

1. A number of calibration cottons were provided by accurately weighing 50-grain samples from cottons which had been conditioned in the standard atmosphere of 65 percent relative humidity and 70 degrees F.

2. The specimens were adjusted to balance a calibration cotton which had been conditioned in the prevailing atmosphere and placed on the back pan of the scales as a weight (fig.1).

3. The sample used as the calibration cotton was checked twice a day against a second calibration cotton to insure that its weight had not changed by collection of dust and lint or loss of lint.

4. Micronaire tests were performed, including one reading on each of two unblended specimens for each cotton. The average results for the two specimens were reported.

5. Tests were performed on each of the following 5 check-test cottons both in the morning and the afternoon for a period of 20 working days:

   (a) Lockett
   (b) Rowden
   (c) Deltapine
   (d) Mesilla Valley
   (e) Pima 32

6. The temperature, relative humidity, and weight of the calibration cotton were checked and reported before and after each morning and afternoon test.

DISCUSSION OF RESULTS

The average trend line for the results of this study in which the test specimens were adjusted for differences in moisture content, indicates that the Micronaire results are slightly higher when the tests are

Figure 1.--Scales with a calibration cotton on the back pan and a specimen on the front pan balanced to provide a specimen whose weight was adjusted for differences in moisture content

performed in atmosphere of low relative humidity than they are when the tests are performed in atmosphere of high relative humidity (fig. 2). This is the reverse of the trend found when specimen weights were held constant. The results obtained in atmosphere of 42 percent relative humidity are calculated to average 0.07 micrograms per inch higher than those obtained in the standard atmosphere of 65 percent relative humidity. On the other hand, the results obtained in atmosphere of 88 percent relative humidity are calculated to average 0.07 micrograms per inch lower than those obtained in the standard atmosphere.

The results also indicate that the effect of relative humidity on the level of the Micronaire values is greater for the coarse-fibered cottons than it is for the fine-fibered cottons. This observation, however, is probably the result of the curvilinear nature of the Micronaire scale. The scale graduations for the higher values are smaller than they are for the lower values.

The average Micronaire value obtained for the five selected cottons ranged from 4.63 to 4.39 micrograms an inch when tested twice on each of 5 days per week for 4 weeks (table 1). During this period, tests were performed in atmosphere ranging from 37 to 87 percent relative humidity and from 70.2 to 82.5 degrees F. (table 2). The weight of the standard calibration cottons during these tests ranged from 49.2 to 52.0 grains.

The accuracy of the reproducibility of Micronaire results when the tests are performed in prevailing atmospheric conditions may be estimated statistically from the 40 individual tests performed on each of 5 cottons in this study. The estimated standard errors of the results are obtained by dividing the ranges by the constant 4.4 3/. These values range from plus or minus 0.06 micrograms per inch for Mesilla Valley to plus or minus 0.12 micrograms per inch for Deltapine. They average plus or minus 0.09 micrograms per inch for the five cottons tested (table 3).

The results of a special study performed in the laboratories of the Cotton Division indicate that the comparable accuracy of the reproducibility of Micronaire results when the tests are performed in standard atmospheric conditions is within an average standard error of plus or minus 0.05 micrograms per inch. A comparison of this average standard error with the comparable average standard error of plus or minus 0.09 micrograms per inch, obtained in this study, shows that the Micronaire results are more precise when the tests are performed in standard atmospheric conditions than they are when the tests are performed in the prevailing atmosphere.

3/ Pearson, E. S. The Probability Integral of the Range in Samples of N Observations from a Normal Population. Biometrika, Vol.32 (1941-42).

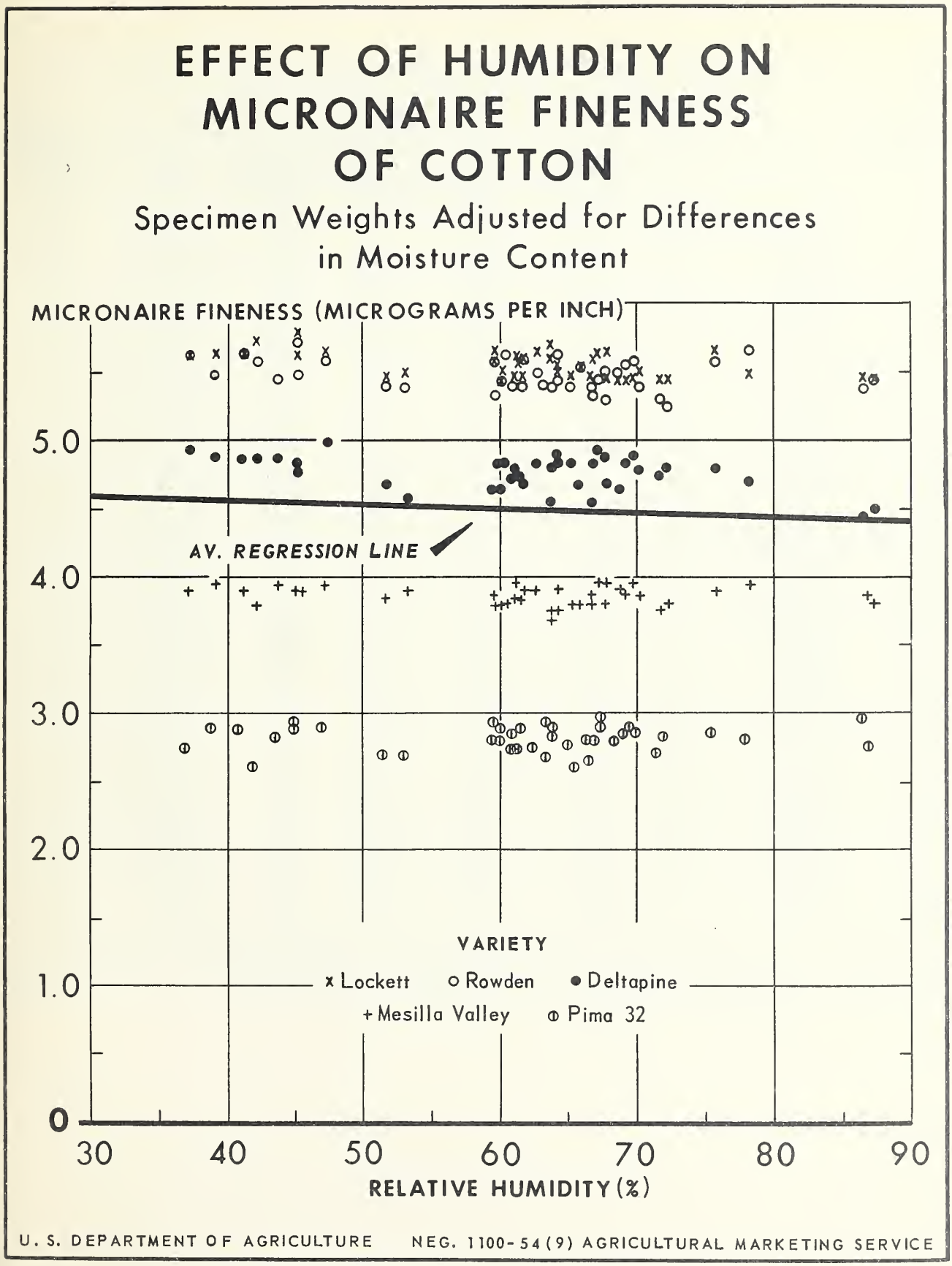
EFFECT OF HUMIDITY ON MICRONAIRE FINENESS OF COTTON
Specimen Weights Adjusted for Differences in Moisture Content
MICRONAIRE FINENESS (MICROGRAMS PER INCH)
5.0
4.0
3.0
2.0
1.0
0
AV. REGRESSION LINE
VARIETY
x Lockett
o Rowden
• Deltapine
+ Mesilla Valley
⊙ Pima 32
30
40
50
60
70
80
90
RELATIVE HUMIDITY (%)
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Figure 2

Table 1.--Micronaire fineness results for 5 check-test cottons tested in the prevailing atmosphere when the specimen weight is adjusted for changes in moisture content, 1954 1/

Identification number	Date	Time	Weight per inch of cotton					
			Lockett	Rowden	Deltapine	Mesilla V.	Pima	Average
			Micrograms	Micrograms	Micrograms	Micrograms	Micrograms	Micrograms
1	3/31/54	AM	5.80	5.75	4.80	3.90	2.90	4.63
2	3/31/54	PM	5.75	5.60	4.90	3.80	2.62	4.54
3	4/1/54	AM	5.65	5.65	4.90	3.90	2.90	4.60
4	4/1/54	PM	5.65	5.50	4.90	3.95	2.90	4.58
5	4/2/54	AM	5.70	5.45	4.90	3.95	2.82	4.56
6	4/2/54	PM	5.65	5.50	4.85	3.90	2.92	4.56
7	4/5/54	AM	5.50	5.40	4.80	3.85	2.85	4.48
8	4/5/54	PM	5.45	5.35	4.85	3.80	2.80	4.45
9	4/6/54	AM	5.70	5.40	4.55	3.70	2.68	4.40
10	4/6/54	PM	5.60	5.40	4.70	3.75	2.95	4.48
11	4/7/54	AM	5.65	5.60	4.80	3.90	2.85	4.56
12	4/7/54	PM	5.65	5.50	4.85	3.90	2.75	4.53
13	4/8/54	AM	5.45	5.55	4.85	3.85	2.85	4.51
14	4/8/54	PM	5.55	5.65	4.85	3.90	2.85	4.56
15	4/9/54	AM	5.65	5.50	4.90	3.95	3.00	4.60
16	4/9/54	PM	5.65	5.45	4.95	3.95	2.80	4.56
17	4/12/54	AM	5.45	5.60	4.90	3.95	2.90	4.56
18	4/12/54	PM	5.55	5.45	4.75	3.95	2.75	4.49
19	4/13/54	AM	5.45	5.30	4.70	3.80	2.90	4.43
20	4/13/54	PM	5.45	5.40	4.75	3.85	2.85	4.46
21	4/14/54	AM	5.50	5.45	4.80	3.75	2.90	4.48
22	4/14/54	PM	5.60	5.35	4.65	3.80	2.80	4.44
23	4/15/54	AM	5.45	5.30	4.75	3.75	2.70	4.39
24	4/15/54	PM	5.45	5.35	4.80	3.80	2.82	4.44
25	4/16/54	AM	5.65	5.60	5.00	3.95	2.90	4.62
26	4/16/54	PM	5.65	5.65	4.95	3.90	2.75	4.58
27	4/19/54	AM	5.65	5.60	4.65	3.85	2.95	4.54
28	4/19/54	PM	5.50	5.65	4.70	3.95	2.80	4.52
29	4/20/54	AM	5.45	5.45	4.50	3.80	2.75	4.39
30	4/20/54	PM	5.45	5.40	4.45	3.85	2.95	4.42
31	4/21/54	AM	5.45	5.50	4.65	3.90	2.80	4.46
32	4/21/54	PM	5.50	5.65	4.85	3.80	2.80	4.52
33	4/22/54	AM	5.60	5.60	4.70	3.90	2.90	4.54
34	4/22/54	PM	5.50	5.40	4.60	3.90	2.70	4.42
35	4/23/54	AM	5.45	5.45	4.70	3.80	2.90	4.46
36	4/23/54	PM	5.45	5.40	4.70	3.85	2.70	4.42
37	4/26/54	AM	5.45	5.50	4.85	3.80	2.75	4.47
38	4/26/54	PM	5.60	5.50	4.80	3.85	2.75	4.50
39	4/27/54	AM	5.50	5.40	4.55	3.85	2.65	4.39
40	4/27/54	PM	5.55	5.55	4.70	3.80	2.60	4.44

1/ Results for the Lockett, Rowden, Deltapine, and Mesilla Valley cottons were based on the curvilinear Micronaire scale for American upland cottons dated September 1950 and those for the Pima 32 cotton were based on the special Micronaire scale for American Egyptian cottons dated January 1952.

Table 2.--Atmospheric conditions and specimen weights when Micronaire tests were performed on cotton, 1954

Identification number 1/	Date	Time	Temperature			Relative humidity			Specimen weight		
			B	A	Average	B	A	Average	B	A	Average
			Degrees F.	Degrees F.	Degrees F.	Percent	Percent	Percent	Grains	Grains	Grains
1	3/31/54	AM	70.5	70.5	70.5	46.0	44.0	45.0	49.3	49.3	49.3
2	3/31/54	PM	70.5	70.0	70.2	40.0	44.0	42.0	49.3	49.6	49.4
3	4/1/54	AM	69.5	71.0	70.2	42.0	40.0	41.0	49.3	49.3	49.3
4	4/1/54	PM	75.0	75.0	75.0	39.0	39.0	39.0	49.3	49.3	49.3
5	4/2/54	AM	72.0	73.0	72.5	45.0	42.0	43.5	49.1	49.5	49.3
6	4/2/54	PM	76.0	75.5	75.8	44.0	46.0	45.0	49.3	49.5	49.4
7	4/5/54	AM	77.5	78.0	77.8	71.0	69.0	70.0	51.0	51.0	51.0
8	4/5/54	PM	77.0	77.5	77.2	67.0	66.0	66.5	50.6	50.6	50.6
9	4/6/54	AM	83.0	82.0	82.5	62.0	65.0	63.5	50.8	50.7	50.8
10	4/6/54	PM	81.0	80.5	80.8	63.0	64.0	63.5	50.3	50.7	50.5
11	4/7/54	AM	76.5	77.0	76.8	76.0	75.0	75.5	51.0	51.2	51.1
12	4/7/54	PM	81.0	81.0	81.0	63.0	62.0	62.5	50.7	50.5	50.6
13	4/8/54	AM	78.5	79.0	78.8	70.0	68.0	69.0	50.8	50.8	50.8
14	4/8/54	PM	80.5	80.5	80.5	64.0	64.0	64.0	50.3	50.5	50.4
15	4/9/54	AM	76.5	76.5	76.5	67.0	68.0	67.5	50.3	50.3	50.3
16	4/9/54	PM	78.0	78.0	78.0	67.0	67.0	67.0	50.2	50.5	50.4
17	4/12/54	AM	77.0	77.0	77.0	68.0	71.0	69.5	51.0	51.0	51.0
18	4/12/54	PM	79.0	79.5	79.2	62.0	60.0	61.0	50.3	50.2	50.2
19	4/13/54	AM	78.0	79.0	78.5	67.0	68.0	67.5	50.2	50.2	50.2
20	4/13/54	PM	80.0	80.0	80.0	61.0	61.0	61.0	50.5	50.5	50.5
21	4/14/54	AM	79.0	79.5	79.2	64.0	64.0	64.0	50.2	50.3	50.2
22	4/14/54	PM	81.0	82.0	81.5	61.0	58.0	59.5	50.1	50.1	50.0
23	4/15/54	AM	79.0	79.5	79.2	71.0	72.0	71.5	50.3	50.3	50.3
24	4/15/54	PM	79.5	79.5	79.5	73.0	71.0	72.0	50.3	50.3	50.3
25	4/16/54	AM	74.0	74.0	74.0	47.0	47.0	47.0	49.6	49.6	49.6
26	4/16/54	PM	75.0	75.0	75.0	37.0	37.0	37.0	49.2	49.2	49.2
27	4/19/54	AM	73.5	74.0	73.8	61.0	58.0	59.5	50.2	49.8	50.0
28	4/19/54	PM	74.0	75.5	74.8	82.0	74.0	78.0	50.8	50.8	50.8
29	4/20/54	AM	74.0	75.0	74.5	88.0	86.0	87.0	52.0	52.0	52.0
30	4/20/54	PM	75.0	75.0	75.0	86.0	87.0	86.5	52.0	52.0	52.0
31	4/21/54	AM	76.0	77.0	76.5	70.0	67.0	68.5	50.6	50.6	50.6
32	4/21/54	PM	78.0	78.0	78.0	60.0	60.0	60.0	50.3	50.5	50.4
33	4/22/54	AM	76.0	77.5	76.8	62.0	61.0	61.5	50.0	50.0	50.0
34	4/22/54	PM	78.5	80.0	79.2	56.0	50.0	53.0	49.8	49.8	49.8
35	4/23/54	AM	78.0	78.0	78.0	60.0	60.0	60.0	49.8	49.8	49.8
36	4/23/54	PM	79.0	80.0	79.5	53.0	50.0	51.5	49.5	49.6	49.6
37	4/26/54	AM	78.5	78.5	78.5	65.0	65.0	65.0	50.0	50.0	50.0
38	4/26/54	PM	80.0	80.0	80.0	61.0	61.0	61.0	49.8	49.8	49.8
39	4/27/54	AM	80.0	81.0	80.5	68.0	65.0	66.5	50.2	50.2	50.2
40	4/27/54	PM	81.5	82.0	81.8	66.0	65.0	65.5	50.2	50.2	50.2

1/ One determination was made before, and one after, the tests were performed on the 5 selected cottons for each period.

Table 3.--Range and statistical error of reproducibility of Micronaire, 40 individual tests performed on 5 cottons

	Weight per inch of cotton					
	Lockett	Rowden	Deltapine	Mesilla Valley	Pima 32	Average
	Micrograms	Micrograms	Micrograms	Micrograms	Micrograms	Micrograms
High	5.80	5.75	5.00	3.95	3.00	
Low	5.45	5.30	4.45	3.70	2.60	
Range	.35	.45	.55	.25	.40	0.40
Standard error	± .08	± .10	± .12	± .06	± .09	± .09

This lowering in precision when tests are performed in the prevailing atmosphere is probably attributable to the fact that no provision is made in the method to compensate for differences in size of fibers from exposure to atmosphere of different relative humidities. The results of this study indicate, however, that when the weights of the specimens are adjusted to compensate for differences in moisture content, the Micronaire values obtained are sufficiently precise for practical application of the method.